



Descriptions of three new species and one subspecies of freshwater hardyhead (Pisces: Atherinidae: *Craterocephalus*) from Australia

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Abstract

Three new species and a new subspecies belonging to the atherinid genus *Craterocephalus* are described. The fish from south-eastern Australia previously recognised as *C. fluviatilis* is described as a subspecies of the more northerly occurring *C. stercusmuscarum*. The two subspecies are distinguished by differences in colour pattern and vertebral counts. A new name, *C. stercusmuscarum fulvus* is proposed because *fluviatilis* is regarded as a junior synonym of *C. eyresii*. A hardyhead from the Northern Territory which has been erroneously identified as *C. marjoriae* is described as a new species — *C. marianae*, based on differences in transverse scale counts, position of the anus, gill raker shape, and colour pattern. Two additional new species, *C. helenae* and *C. lentiginosus* are described from the Kimberley region of Western Australia. The former species is closely allied to *C. marianae* but differs in counts of midlateral scales, vertebrae, and gill rakers. *Craterocephalus lentiginosus* is most closely related to *C. stercusmuscarum*, but differs from it in having consistently lower meristic counts and by the presence of a lateral process on the premaxilla.

Introduction

The family Atherinidae contains approximately 170 species. These relatively small, silvery fishes occur worldwide mainly in marine or estuarine habitats but several genera including *Craterocephalus* McCulloch of Australia and New Guinea is primarily found in fresh water. Ivantsoff (1978) reviewed the status of all the nominal species in this genus, recognising 10 as valid. However, some of his findings were inconclusive. A new study of the genus by Ivantsoff and Crowley, encompassing osteology and electrophoresis is currently in progress.

Recent collections in north-western Australia have resulted in the discovery of two new species of *Craterocephalus* (Allen, 1982). In addition, the fish from the Northern Territory previously identified as *Craterocephalus marjoriae* Whitley

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(1948), is described here as another new species. Ivantsoff (1978) indicated that a species of fish known as *Craterocephalus fluviatilis* McCulloch (1913), is different in coloration but indistinct morphologically from *C. stercusmuscarum* (Günther, 1867). In the present paper these forms are recognised as distinct subspecies on the basis of their allopatric distribution and slight differences in meristics and morphology.

Methods for counts and measurements are based on Munro (1967), but modified in several instances as described by Prince *et al.* (1982) and Patten and Ivantsoff (1983). In *Craterocephalus* the second dorsal and anal fins may or may not have an unbranched ray preceding the branched rays. For the sake of uniformity, the first ray following the spine in both these fins was not considered as part of the branched ray count. Radiographs were utilised to obtain vertebral counts. The number of specimens examined, their provenance and where presently held is indicated in relevant sections. Measurements and counts are recorded for all type specimens. Specimens examined have been borrowed from or deposited in the following institutions: American Museum of Natural History, New York, field registrations (AMNH – DR); Australian Museum, Sydney (AMS); British Museum of Natural History, London (BMNH); California Academy of Sciences, San Francisco (CAS); Macquarie University, Sydney (MQU); Queensland Museum, Brisbane (QM); Museum of Zoology, University of Michigan, Ann Arbor, USA (UMMZ); and Western Australian Museum, Perth (WAM).

Systematics

Craterocephalus stercusmuscarum fulvus subsp. nov.

Figure 1

Craterocephalus fluviatilis McCulloch, 1913: 49 (in part) (Narrandera, New South Wales).

Holotype

AMS I.25480-001, 40.7 mm SL, Wirrabilla Lagoon, Wirrabilla Station, Collarenebri, New South Wales, 29°33'S, 148°35'E, collected by D.G. Stead, 3 May 1910. Method of collection unknown.

Paratypes

AMS IB.784 (41, of which only 20 measured and counted), (21.5-40.2 mm SL), Wirrabilla Lagoon, Wirrabilla Station, as above.

Diagnosis

A subspecies of the atherinid genus *Craterocephalus* differing from the nominal *C. stercusmuscarum stercusmuscarum* by lacking a spotted colour pattern and possessing a slightly higher vertebral count (31-36 v. 35-38). It is distinguished from *C. eyresii* by a lower number of horizontal scale rows on the body (usually 7 v. 10-18), and by having thick rather than thin lips. *Craterocephalus stercus-*

muscarum fulvus is distinguished from all other species and subspecies of *Craterocephalus* by a combination of characters that includes the following: relatively small, slender fish with 7.0-7.5 rows of scales along side of body; spots on side of body absent, black band through snout, midlateral band black, gold or silvery; mouth small, gape restricted, and lips thick.

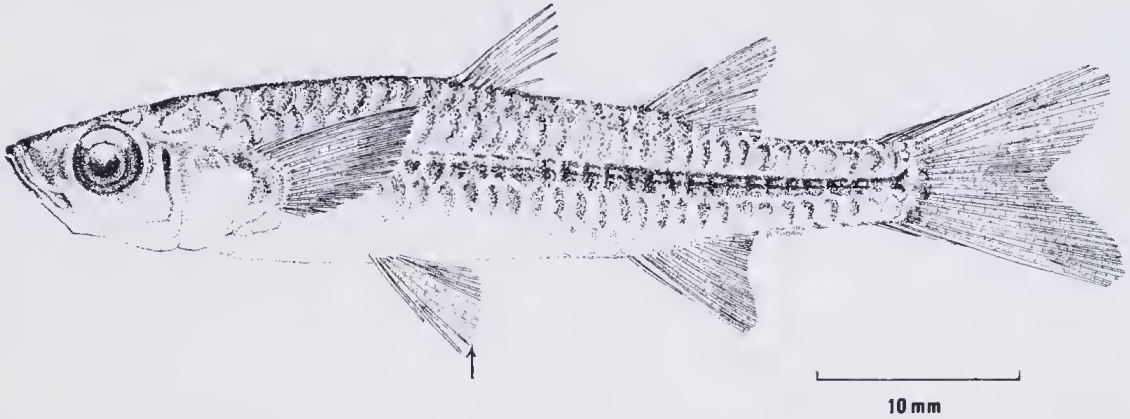


Figure 1 *Craterocephalus s. fulvus* AMS I.25448-001 Sandy Creek, Northern New South Wales, 53.4 mm SL. Arrow near ventral fin indicates position of anus.

Description

Small fish not known to exceed 63 mm SL. Mouth small, protrusible, with gape restricted by fusion of lips. Premaxilla short, not reaching vertical through anterior margin of orbit, its free edge slightly concave anteriorly and convex posteriorly. Dorsal process of premaxilla long and pungent but not reaching into interorbital space. Ramus of dentary highly elevated posteriorly. Minute teeth in several rows in both jaws. Other bones in mouth edentulous. Preopercle and opercle scaled. Body scales large, dorsoventrally oval, with circuli complete and concentric. Scales in seven distinct rows along side of body. Gill rakers in first lower gill arch short and tubercular, less than half diameter of pupil. Large specimens often with shallow interorbital trough and with head sloping obliquely towards snout.

Colour: Live specimens bright golden yellow (Namoi River, NSW) or greenish gold (Fraser Island, Queensland); frequently dull yellow in captivity. Black band originating from tip of snout, extending through eye and continuing as black, gold or silvery midlateral band to hypural joint. Female with black blotch around vent when reproductively mature.

Preserved specimens yellow to brown with band as described above. Upper half of body darker than abdomen. Dorsum of head often black. Body scales with fine speckling at edges. No large regular spots along side of body as in *C. s. stercusmuscarum*.

Etymology: *fulvus*, pertaining to yellow or tawny hue which is the usual coloration of this subspecies. This fish is commonly referred to as the Mitchellian Hardyhead.

Remarks

McCulloch's (1913) account of *C. fluviatilis* is based on the holotype and five paratypes from Narrandera and 20 specimens from the Barwon and Namoi River Junction. McCulloch found that the 20 specimens from the Barwon and Namoi, had seven scale rows, whereas those from Narrandera, the type locality, had scale row counts ranging from 7-10.

Examination of the type material of *C. fluviatilis* indicates more than nine scale rows along the side of the body in the holotype and two paratypes. These have been reidentified as *C. eyresii* (Steindachner, 1884), a species in which the scale row count varies from 10 to 18 (Ivantsoff 1980). The remaining three paratypes from Narrandera, including McCulloch's (1913) figured specimen, are conspecific with the designated types of *C. s. fulvus* from Wirrabilla Lagoon. In these, there are never more than seven scale rows along side of body although McCulloch (1913) sometimes counted eight, presumably because of a difference in the technique of counting.

It appears that McCulloch (1913) had difficulty in distinguishing between *C. fluviatilis* and *C. eyresii* and in 1918, McCulloch and Waite stated that the two species were very closely related. As the holotype of *C. fluviatilis* cannot be distinguished from *C. eyresii*, it is now regarded as its junior synonym.

The account of *C. stercusmuscarum* from south-eastern Australia by Ivantsoff (1980: 134) refers to the new subspecies.

Initial results of electrophoretic studies by Crowley (unpublished) indicate that the unspotted (*C. s. fulvus*) and spotted (*C. s. stercusmuscarum*) subspecies show no differences in the 16 loci examined electrophoretically. Nor can they be distinguished on meristic (other than vertebral counts) and morphometric values and must therefore be regarded as conspecific.

Juvenile and smaller specimens of either subspecies of *C. stercusmuscarum* from the Northern Territory may be unspotted as recorded by Taylor in 1964 (all under 37 mm SL and identified as *C. fluviatilis*). Similar observations have been made in other populations in the range considered to be occupied by *C. s. stercusmuscarum*. We conclude, therefore, that juveniles of the two subspecies cannot be distinguished by any of the external characters considered in this study.

C. s. fulvus is not uncommon in most parts of the Murray-Darling drainage system in New South Wales, Victoria and South Australia. It occurs in central Australia and extends as far north as Maryborough, Queensland.

Additional material examined

AMS IB.787 (6), Mungabarina, Murray River; MQU 75-16 (20) Wabby Lake, Fraser Island, Queensland; AMS I.18532-001 (2), Namoi River, Manilla, New South Wales; AMS IB.786 (3) Hart's Island, Murray River, South Australia; AMS IB.785 (3) Barwon River near Collarenebri,

New South Wales; AMS I.12458 (1), AMS IB.783 (3) Junction of Barwon and Namoi Rivers, New South Wales; AMS I.25448-001 (3) Sandy Creek, New South Wales; MQU 75-20 (1) Macintyre River, Goondiwindi, Queensland. Measurements expressed as proportions and counts for 63 specimens are presented in Table 1.

Other material examined, but not used for measurements and counts: AMS I.12457 (3) North Yanko Creek, Narrandera, New South Wales (paratypes of *C. fluviatilis*); AMS I.690 (2) Cudjegang River, New South Wales; AMS IA.7180 (5) Condamine River, Queensland; AMS IB.4164 (2) Wentworth, Murray River, New South Wales; AMS I.6200-001 (3) Albury, Murray River, New South Wales; AMS I.17898-001 (2) Lake Cargelligo, New South Wales; AMS 16908-003 (6) Dixon Dam, New South Wales; AMS I.18514-001 (9), AMS I.18539-001 (20) Wabby Lake, Fraser Island, Queensland; AMS I.19062-003 (2) Borah Creek, New South Wales; MQU 77-2 (4) Keepit Dam, New South Wales; QM I.13980 (2) Kobble Creek near Samford, Queensland; QM I.13981 (2) North Pine River, Dayboro, Queensland; QM I.13982 (2) Enoggera Creek, The Gap, Brisbane, Queensland; QM I.13938 (2) Pullen Pullen Creek near Kenmore, Queensland; QM I.13921 (2) Gold Creek, Brookfield near Brisbane, Queensland. Size range 19.0-63.0 mm SL.

Craterocephalus lentiginosus sp. nov.

Figure 2

Holotype

WAM P25029-003, 43.3 mm SL Derris powder over sandstone bottom at depths to 2 m, Upper Roe River, 70-80 km upstream from the sea, Kimberley, Western Australia (approx. 15°31'S, 125°38'E), collected by G.R. Allen, 18 August 1974.

Paratypes

Nineteen specimens: WAM P25029-003 (6), data as for holotype; WAM P25029-003 (2) prepared alizarin specimens, data as for holotype; AMS I.24115-001 (4) data as for holotype; AMS I.24115-002 (2) prepared alizarin specimens, data as for holotype. WAM P25028-003 (6), derris powder over sandstone and mud bottom in a quiet pool (approximately 10 by 60 m) at depths to 2 m, Wyulda Creek, about 2 km above junction with Roe River, Kimberley, Western Australia (approximately 15°31'S, 125°38'E) collected by G.R. Allen, 17 August 1974. Size range 21.9-43.3 mm SL. Measurements expressed as proportions and counts for the holotype and 19 paratypes are presented in Table 2.

Diagnosis

A species of the atherinid genus *Craterocephalus* most closely allied to *C. stercusmuscarum*, but differing in counts for midlateral scales (29-31 v. 32-35 for *stercusmuscarum*), predorsal scales (12-15 v. 11-17) and vertebrae (32-33 v. 31-38). It is further distinguished from all other species and subspecies of *Craterocephalus* by a combination of characters that includes the following: relatively small, slender fish with 5-7 rows of large, almost rectangular scales along side of body; spots on upper four rows of scales only, black band extending from snout through opercle and continuing as midlateral band to hypural joint; midlateral scales 29-31; vertebrae 32-33; lateral process of premaxilla well developed, its upper tip pointing posteriorly.

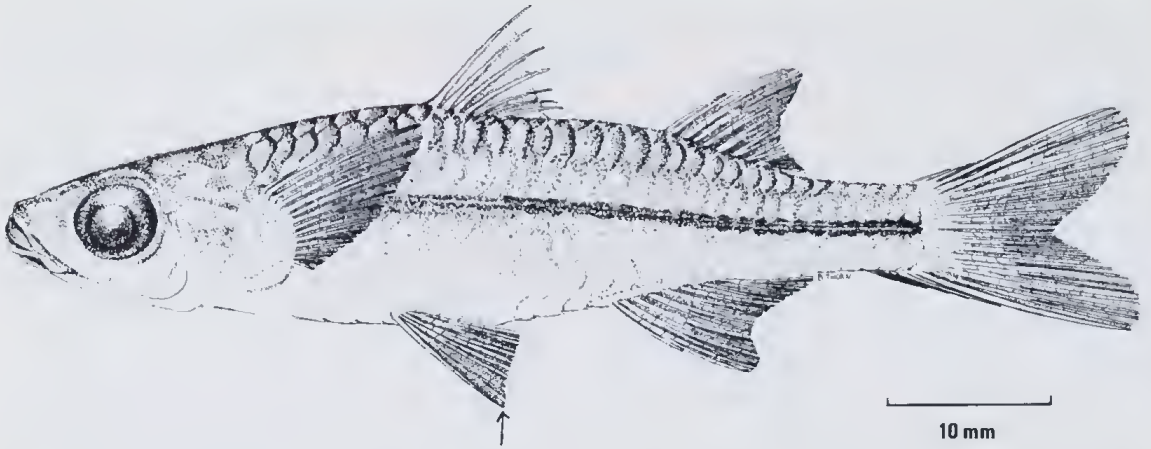


Figure 2 *Craterocephalus lentiginosus*, holotype, WAM P.25029-003, Upper Roe River, Kimberley, Western Australia, 43.3 mm SL.

Description

Slender fish, maximum known size 43.3 mm SL. Mouth small, protrusible, gape restricted by fusion of lips. Lips moderately thick. Premaxilla short, not reaching vertical through anterior margin of orbit, its free edge concave anteriorly and slightly convex posteriorly. Dorsal process of premaxilla long and pungent, extending to just past vertical through anterior margin of orbit. Lateral process of premaxilla well developed, falcate, with dorsal tip pointing backwards. Ramus of dentary highly elevated posteriorly. Well formed teeth in two rows on anterior half of both jaws. Other bones in mouth edentulous. Body scales large, dorsoventrally elongated almost rectangular with concentric circuli anteriorly, incomplete posteriorly. Scales in five or six regular rows along side of body. Preopercle with 4-5 scales. Opercle also scaled. Small, spinule covered, tubercular gill rakers on first lower gill arch.

Colour: Preserved specimens yellow to dusky brown. Dark brown band originating on snout, extending through eye, opercle and continuing as dark punctate midlateral band to hypural joint. Pigment in large spots in centre of each scale of upper four rows (including midlateral row) forming discontinuous bands of varying intensity along side of body. Juveniles and smaller fish with less pigmentation and lighter in appearance. Upper half of body in adults dusky with fine peppering of melanophores concentrated on each scale. Ventral half of body almost devoid of pigment below fourth scale row. Head, snout and lips dark. All fins dusky. Dark pigmentation at bases of fins. Middorsal and midventral line of pigment apparent in posterior half of body.

Etymology: *lentiginosus*, referring to the freckled or spotted appearance of this species. We recommend the common name Freckled Hardyhead.

Remarks

The account of *C. worrelli* Whitley from the Roe River by Allen (1975) represents a misidentification of *C. lentiginosus*. In addition Allen (1982) referred to it as *Craterocephalus* species B.

This species is thus far known only from the Roe River in the western Kimberley, Western Australia.

Craterocephalus helenae sp. nov.

Figure 3

Holotype

WAM P25456-003, 56.5 mm SL, down stream from Gibb River Road, Kimberley, Western Australia, 15°41'S, 126°32'E. Sand and rocky bottom. Rotenone, collected by J.B. Hutchins, 31 August 1975.

Paratypes

Twenty-eight specimens: WAM P25456-003 (8) data as for holotype; WAM P25406-009 (2) Drysdale River Channel near Mogurnda Creek, Kimberley, Western Australia, 15°02'S, 126°55'E. Sand and rocky bottom. Rotenone, collected by J.B. Hutchins, 5 August 1975; WAM P25424-008 (2) and alizarin preparations (2), Drysdale River, small channel near Fern Gully Creek, Kimberley, Western Australia, 14°39'S, 126°57'E. Sand and rocky bottom. Rotenone and seine net, collected by J.B. Hutchins, 19 September 1975. WAM P25873-010 (8) Drysdale River, Kimberley, Western Australia, 15°39'S, 126°21'E, collected by G.R. and C. Allen and G. Evans, 16 September 1977; AMS I.25436-001 (5) data as for WAM P25873-010; AMS I.25449-001, alizarin preparation (1), data as for WAM P25424-008. Measurements expressed as proportions and counts for 26 paratypes and the holotype are presented in Table 4. Size range 35.4-61.3 mm SL.

Diagnosis

A species of the atherinid genus *Craterocephalus* closely allied to *C. marjoriae* Whitley and *C. marianae* sp. nov., but differing from them by a combination of

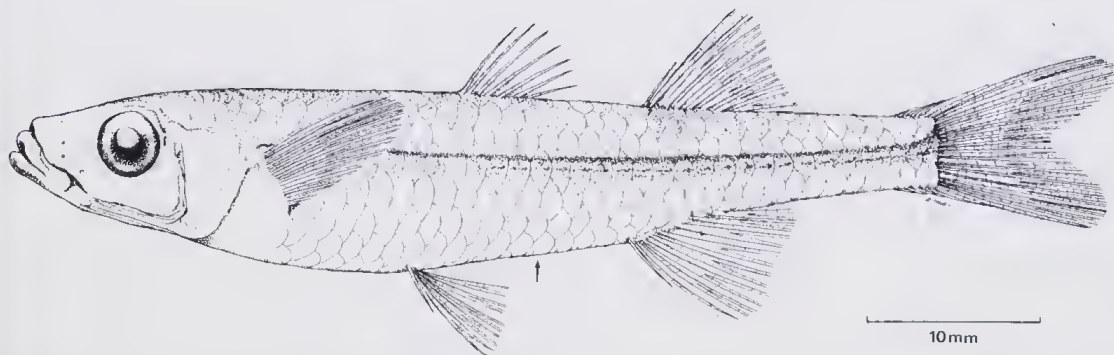


Figure 3 *Craterocephalus helenae*, holotype, WAM P.25456-003 Drysdale River, Kimberley, Western Australia, 56.5 mm SL.

characters that includes a low gill raker count (8-10; \bar{x} = 8.9 v. 10-12; \bar{x} = 11.1-11.2), a higher mean count for midlateral scales (30-32; \bar{x} = 29.4 v. 27-30; \bar{x} = 28.4 and 29.4), and a higher mean count for vertebrae (32-33; \bar{x} = 32.9 v. 29-34; \bar{x} = 30.2 and 31.6). Further comparisons of the members of this closely related group are indicated in Table 6.

Description

Small but moderately robust fish, presently known maximum size about 61.3 mm SL. Head relatively rounded and truncate. Mouth small, gape restricted by fusion of lips. Lips moderately thick. Mouthparts protrusible with upper jaw extending slightly over lower when extended forward. Premaxilla longer than in other species presently described but not quite reaching vertical through anterior margin of orbit. Anterior free edge of premaxilla concave, posterior half covered by lips. Dorsal process of premaxilla long and pungent extending almost to vertical through anterior margin of orbit. Posterior ramus of premaxilla wide and culminating in round eminence. Ramus of dentary highly elevated posteriorly, curving forwards at dorsal end. Upper jaw with fine teeth pointing posteriorly and almost at right angles to free edge of premaxilla. Lower jaw expanding anteriorly to form wide, edentulous plate. Other elements of mouth also edentulous. Body scales large, sturdy, dorsoventrally elongated, almost rectangular and scalloped anteriorly; circuli restricted to anterior half of scale. Scales in about 5.5 distinct rows along side of body. Four scales on preopercle and four large scales on opercle. First 4-5 scales on dorsum of head rectangular and large. Gill rakers in angle of first lower gill arch short and leaf-like, those following, reduced to slight elevations covered with fine spinules.

Colour: Preserved specimens yellow brown. Midlateral band, about one-third of scale width, extending from origin of pectoral to caudal base, its upper edge marked by concentration of fine melanophores forming thin, streaky line. Upper half of body more dusky than lower, with greater concentration of very fine melanophores, particularly at posterior edge of scales. Dorsum of head dark; snout, premaxilla and opercle speckled with chromatophores in various concentrations and sizes. Lower half of body speckled but less so than upper half, with ventral surface almost unpigmented. All fins finely peppered with melanophores.

Etymology: *helenae* is named in honour of the senior author's wife Helena. We recommend the common name Helena's Hardyhead.

Remarks

The records of *C. marjoriae* by Lake (1978, in part) and Hutchins (1977) from the Northern Territory and Kimberley respectively are referable to *C. helenae*. Allen (1982) identified it as *Craterocephalus* species A.

This species is known only from the Drysdale River in the north-central Kimberley, Western Australia.

Craterocephalus marianae sp. nov.

Figure 4

Holotype

AMS I.18523-001, 55.4 mm SL, Magela Creek, Jabiru, Northern Territory, 12°41'S, 132°55'E, collected with seine by D. Pollard and M. Mann, June 1972.

Paratypes

Thirty specimens measured and counted, AMS I.18523-001 (7) data as for holotype; AMS I.18541-001 (11) data as for holotype, but collected in July 1972; AMS I.16859-001 (12), data as for holotype but collected in July 1972.

Designated as paratypes but not included in measurements and counts: WAM P.28195-001 (10) data as for AMS I.16859-001; BMNH 1983. 12.8.1-5.(5) data as for AMS I.16859-001; CAS 53748 (5) data as for AMS I.16859-001; UMMZ 212.147 (5) data as for AMS I.16859-001. Size range 36.4-59.4 mm SL.

Diagnosis

A species of the atherinid genus *Craterocephalus* belonging to the *eyresii* species complex as defined by Ivantsoff (unpublished) and closely allied to *C. marjoriae* Whitley and *C. helenae* sp. nov. It appears closest to *C. helenae*, but is distinguished from that species by lower counts of midlateral scales (27-30 v. 30-32) and vertebrae (29-31 v. 32-33), higher gill raker counts (8-10 v. 10-11), the presence of a row of spots below the midlateral scales, and a more rounded snout. It differs from *C. marjoriae* in having less horizontal scale rows below the midlateral band (2.5 v. 3.5), in having the anus at or in front of the tips of the ventral fins rather than behind them, and in possessing low, rudimentary gill rakers rather than well formed tubercular rakers. Further comparisons are indicated in Table 6.

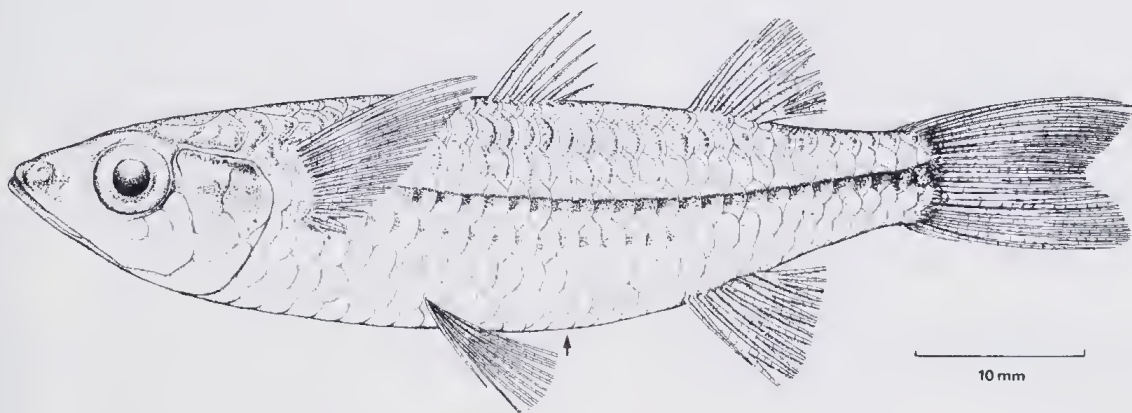


Figure 4 *Craterocephalus marianae*, holotype, AMS I.18523-001 Magela Creek, Jabiru, Northern Territory, 55.4 mm SL.

Description

The following description is based on measurements and counts taken from the holotype and 30 paratypes unless otherwise indicated (Table 5). Live specimens collected in the Magela Creek, Northern Territory, were utilised for colour variability and patterns.

Small, moderately robust fish, maximum known size about 60 mm SL. Dorsum of head above snout convex and sloping towards mouth. Mouth small, gape restricted by fusion of lips. Lips moderately thick. Mouthparts protrusible, upper jaw slightly overlying lower, when extended forward. Premaxilla longer than in other species of *Craterocephalus*, just reaching vertical through anterior margin of orbit. Anterior free edge of premaxilla markedly concave, posterior half slightly convex and covered by fleshy lip. Dorsal process of premaxilla long and pungent, extending to vertical through anterior margin of orbit. Posterior ramus of premaxilla wide and culminating in round eminence. Ramus of dentary highly elevated posteriorly, curving forwards at dorsal end. Upper jaw with fine teeth pointing posteriorly and almost at right angles to free edge of premaxilla. Lower jaw expanding anteriorly to form wide edentulous plate. Other elements of mouth also edentulous. Body scales large, sturdy, dorsoventrally elongated, ellipsoid to rectangular, scalloped anteriorly. Circuli restricted to anterior half of scale. Scales always in 5.5 scale rows along side of body. Preopercle with three scales. Opercle with four large scales. Scales on dorsum of head rectangular and large. Gill rakers in angle of first lower gill arch short and leaf-like, those following, reduced to elevations covered by spinules.

Colour: Live specimens sandy yellow, translucent, with thin black midlateral stripe more prominent on posterior half of body. Upper half of body darker than lower. Peritoneum clearly visible, outlining abdominal cavity. Dorsum and sides of head darker than body, opercular region reddish or opalescent. Rows of spots below midlateral band often present. Fins hyaline and unpigmented. Preserved specimens various hues of yellow. Midlateral band, brown, about half scale width, more prominent in posterior half of body and frequently punctuated by darker spot on each scale. Scales on upper half of body often edged by melanophores, those below with no such marking. Often with two rows of spots below midlateral band, fading away towards hypural joint. Dorsum of head dark, eyes black, peritoneum visible as black mark ventrally, in front and behind ventral fins. Fins clear and unpigmented.

Etymology: *marianae* is named in honour of the senior author's daughter Mariana. We recommend the common name Mariana's Hardyhead.

Remarks

This species has frequently been misidentified as *C. marjoriae* Whitley by previous workers including Pollard (1974), Lake (1978, in part), and Ivantsoff (1980, in part).

Preliminary biochemical analysis by the second author indicates there are genetic differences between *C. marianae* and *C. marjoriae* at 8 of 16 loci examined. The enzymes encoded by these loci were *Malic enzyme*, *6 Phosphogluconate dehydrogenase*, *Fumarase*, *Phosphoglucomutase*, *Superoxide dismutase*, *Mannosephosphate isomerase*, *Phosphoglucose isomerase* and *Glutamate oxaloacetate transferase*.

C. helenae, *C. marianae* are quite distinct from *C. marjoriae* whilst the similarity between *C. helenae* and *C. marianae* makes them more difficult to separate. It would appear that geographic isolation between the Kimberley and the rest of northern Australia which has made *C. lentiginosus* distinct within the *stercus-muscarum* complex, has also allowed for independent paths of evolution for *C. marianae* and *C. helenae* within the *eyresii* complex.

C. marianae (identified as *C. marjoriae* by Ivantsoff 1978, 1980) has been the subject of intensive biological investigation by Bishop *et al.*, (in press) and by Ivantsoff *et al.*, (in press). Its abundance has allowed the above authors to determine the fishes' habitat preferences and preferred physical parameters, spawning sites, breeding seasonality, fecundity, embryo and larval development, feeding habits and growth rates. Its mortality curves during the 'dry' season in the Magela Creek have been examined by Ward (1982). *C. marianae* is therefore one of the best studied small, non-commercial freshwater fish in Australia.

This species is known only from the Magela Creek drainage of the East Alligator River System, Northern Territory.

Additional material examined

Mudginbarri Lagoon, Northern Territory, 12°26'S, 132°52'E, AMS I.16857-001 (27); isolated pool, 4 km south of South Alligator River crossing, Northern Territory, 12°23'S, 132°58'E, AMS I.17726-001 (20); Pine Creek, Oenpelli Road, South Alligator River, Northern Territory, approximately 12°21'S, 133°02'E, AMNH-DR 1969-112 (13).

Descriptions of three new species and one subspecies of freshwater hardyheads

Abbreviations used in all tables: SL, standard length; Pec L, length of longest pectoral rays; H max, greatest body depth; H min, least body depth at caudal peduncle; Sn, snout; OD1, origin of first dorsal fin; OD2, origin of second dorsal fin; OV, origin of ventral fin; TPec, tips of pectoral fins; TV, tips of ventral fins; OA, origin of anal fins; TA, point of last ray insertion of anal fin. Position of fins and anus is expressed as a number of scales in front (F) or behind (B) the point of reference. S D, standard deviation.

Table 1 Measurements expressed as proportions and counts of the holotype and other 62 specimens including 20 paratypes of *Craterocephalus stercusmuscarum fulvus*.

SL	Holotype	Paratypes and 42 other		
	40.7 mm	19.0-63.0 mm		
		For all specimens:		
		mean	range	SD
In SL				
Head	3.3	3.5	(3.2-4.0)	.18
Pec L	6.3	6.2	(3.7-9.0)	.96
H max	4.6	5.2	(4.4-6.0)	.39
H min	12.5	12.5	(10.2-15.0)	1.2
Sn-OD1	1.9	2.0	(1.9-2.3)	.08
Sn-OD2	1.3	1.4	(1.3-1.5)	.04
Sn-OV	2.0	2.1	(1.9-2.3)	.10
Sn-TV	1.6	1.7	(1.6-1.8)	.05
Sn-OA	1.4	1.4	(1.3-1.5)	.05
Sn-TA	1.2	1.2	(1.1-1.3)	.05
In Head				
Eye	3.3	3.2	(2.5-3.8)	.26
Interorbital	2.8	3.0	(2.2-3.7)	.32
Postorbital	2.2	2.4	(2.0-2.8)	.16
In Eye				
Snout	1.2	1.3	(0.9-1.7)	.23
Premaxilla	1.2	1.3	(1.0-1.6)	.14
Dorsal process of premaxilla	1.5	1.5	(1.0-2.1)	.22
Scale Counts				
Midlateral	32	33.4	(32-35)	.86
Transverse	7	7.0	(7.0-7.5)	.14
Predorsal	15	14.0	(11.0-17.0)	1.34
Interdorsal	7	7.1	(6.0-8.0)	.65
Fin Elements				
First dorsal spines	6	6.4	(4.0-8.0)	.75
Second dorsal rays	5	6.3	(5.0-9.0)	.69
Anal rays	7	7.5	(6.0-9.0)	.68
Pectoral rays	11	12.1	(11.0-14.0)	1.12

Table 1 (continued)

SL	Holotype	Paratypes and 42 other		
	40.7 mm	19.0-63.0 mm		
		For all specimens:		
		mean	range	SD
Position of Fins				
OD1 to TV	F4.5	F4.5	(F3-F6)	.83
OD1 to TPec	B2.0	B1.9	(0-B3.5)	.88
OV to TPec	0	F0.6	(F3-B2)	1.70
Other Values				
Gill rakers in first				
lower gill arch	11	11.3	(10-13)	.87
Position of anus to TV	0	F0.3	(F1.5-B1.0)	.61
Vertebrae	33	34.5	(31-36)	.93

Table 2 Measurements and counts for 15 specimens (holotype and paratypes) of *Craterocephalus lentiginosus* (unless otherwise indicated #)

SL	Holotype	15 paratypes		
	43.3 mm	21.9-43.3 mm		
		For all specimens:		
		mean	range	SD
In SL				
Head	3.5	3.5	(3.2-3.7)	.14
Pec L	5.7	#14 6.1	(5.3-6.9)	.47
H max	4.8	5.0	(4.6-5.4)	.25
H min	10.8	11.1	(9.9-12.5)	.69
Sn-OD1	2.0	2.1	(2.0-2.2)	.07
Sn-OD2	1.4	1.4	(1.4-1.5)	.05
Sn-OV	2.3	2.2	(2.0-2.4)	.1
Sn-TV	1.7	1.7	(1.6-1.7)	.04
Sn-OA	1.4	1.4	(1.4-1.5)	.05
Sn-TA	1.3	1.2	(1.2-1.3)	.05
In Head				
Eye	3.4	3.2	(3.0-3.5)	.15
Interorbital	2.9	3.0	(2.6-3.3)	.16
Postorbital	2.4	2.5	(2.4-2.7)	.10
In Eye				
Snout	1.1	1.3	(1.0-1.5)	.16
Premaxilla	1.1	1.3	(1.1-1.6)	.12
Dorsal process of premaxilla	1.8	1.6	(1.4-1.8)	.15

Descriptions of three new species and one subspecies of freshwater hardyheads

Table 2 (continued)

SL	Holotype 43.3 mm		15 paratypes 21.9-43.3 mm		
			For all specimens:		
			mean	range	SD
Scale Counts					
Midlateral	30		29.7	(29-31)	.60
Transverse	6		6.1	(5-7)	.52
Predorsal	14		13.2	(12-15)	.94
Interdorsal	7		6.8	(6-7)	.40
Fin Elements					
First dorsal spines	6		6.9	(6-8)	.50
Second dorsal rays	7		6.4	(6-7)	.51
Anal rays	7		7.4	(7-8)	.50
Pectoral rays	12		11.7	(11-13)	.60
Position of Fins					
OD1 to TV	F5		F5.3	(F4-F6)	.60
OD1 to TPec	B2	#14	B1.2	(0-B3)	.89
OV to TPec	0	#14	F0.8	(0-F2)	.58
Other Values					
Gill rakers in first lower gill arch					
	9		9.4	(8-11)	1.15
Position of anus to TV	0		F1.1	(0-F2)	.69
Vertebrae	32		32	(32-33)	.26

Table 3 Meristic values distinguishing *C. lentiginosus*, *C. s. stercusmuscarum* and *C. s. fulvus*. Data for *C. s. stercusmuscarum* taken from Ivantsoff (1978).

	<i>C. lentiginosus</i>	<i>C. s. stercus- muscarum</i>	<i>C. s. fulvus</i>
	mean range	mean range	mean range
Midlateral scales	29.7 (29-31)	32.9 (32-34)	33.4 (32-35)
Transverse scales	6.1 (5-7)	7.0 (6.5-7)	7.0 (7-7.5)
Predorsal scales	13.2 (12-15)	16.1 (12-18)	14.0 (11-17)
Vertebrae	32.0 (32-33)	36.7 (35-38)	34.5 (31-36)

Table 4 Measurements expressed as proportions and counts for 26 specimens (holotype and paratypes) of *Craterocephalus helenae* (unless otherwise indicated #).

SL	Holotype 56.5 mm	25 paratypes 35.4-61.3 mm		
		For all specimens:		
		mean	range	SD
In SL				
Head	3.4	3.3	(3.2-3.6)	.11
Pec L	4.9	4.8	(4.1-5.0)	.32
H max	4.2	4.3	(4.0-4.7)	.17
H min	11.0	10.4	(9.4-11.1)	.50
Sn-OD1	2.1	2.1	(2.0-2.1)	.05
Sn-OD2	1.4	1.4	(1.3-1.4)	.02
Sn-OV	2.3	2.2	(2.0-2.3)	.08
Sn-TV	1.7	1.6	(1.5-1.7)	.06
Sn-OA	1.5	1.4	(1.4-1.5)	.03
Sn-TA	1.2	1.2		
In Head				
Eye	3.7	3.4	(3.2-3.8)	.20
Interorbital	3.2	3.1	(2.7-3.3)	.17
Postorbital	2.5	2.5	(2.4-2.7)	.08
In Eye				
Snout	0.9	1.0	(0.8-1.2)	.11
Premaxilla	0.9	1.0	(0.9-1.2)	.08
Dorsal process of premaxilla	1.0	1.1	(0.9-1.3)	.11
Scale Counts				
Midlateral	31	31.2	(30-32)	.63
Transverse	5.5	5.6	(5.5-6.0)	.17
Predorsal	11	11.4	(10-13)	.80
Interdorsal	6	7.4	(6-8)	.58
Fin Elements				
First dorsal spines	7	5.8	(5-7)	.63
Second dorsal rays	8	6.3	(5-7)	.67
Anal rays	8	6.3	(5-7)	.63
Pectoral rays	12	12.3	(12-13)	.45
Position of Fins				
OD1 to TV	F5.5	F4.4	(F3-F6)	.70
OD1 to TPec	F1	F1.0	(0-F2.0)	.57
OV to TPec	F2	F2.6	(F1.5-F4.0)	.64
Other Values				
Gill rakers in first				
lower gill arch	8	8.9	(8-10)	.67
Position of anus to TV	F1	F0.9	(0-F1.5)	.39
Vertebrae	33 #24	32.9	(32-33)	.33

Descriptions of three new species and one subspecies of freshwater hardyheads

Table 5 Measurements and counts for 31 specimens (holotype and paratypes) of *Craterocephalus marianae* (unless otherwise indicated #).

SL	Holotype	30 paratypes		
	55.4 mm	36.4-59.4 mm		
		For all specimens:		SD
		mean	range	
In SL				
Head	3.2	3.2	(3.0-3.4)	.11
Pec L	4.8	4.8	(4.4-5.3)	.24
H max	4.2	4.4	(4.0-4.8)	.16
H min	9.1	9.1	(8.7-10.2)	.38
Sn-OD1	2.0	2.0	(1.9-2.1)	.06
Sn-OD2	1.4	1.4	(1.3-1.4)	.07
Sn-OV	2.1	2.2	(2.1-2.3)	.07
Sn-TV	1.6	1.6	(1.6-1.7)	.02
Sn-OA	1.4	1.4	(1.3-1.4)	.02
Sn-TA	1.2	1.2	(1.2-1.3)	.02
In Head				
Eye	3.1	3.3	(3.0-3.7)	.15
Interorbital	2.9	2.9	(2.5-3.1)	.13
Postorbital	2.5	2.6	(2.4-2.8)	.11
In Eye				
Snout	1.1	1.0	(0.8-1.2)	.10
Premaxilla	1.0	1.0	(0.8-1.2)	.08
Dorsal process of premaxilla	1.0	1.1	(0.9-1.3)	.10
Scale Counts				
Midlateral	29	28.4	(27-30)	.61
Transverse	5.5	5.5		
Predorsal	13	11.7	(11-13)	.70
Interdorsal	6	6.2	(6-7)	.38
Fin Elements				
First dorsal spines	6	6.0	(5-7)	.48
Second dorsal rays	5	5.1	(5-6)	.34
Anal rays	6	6.0	(5-7)	.26
Pectoral rays	13	12.6	(11-14)	.72
Position of Fins				
OD1 to TV	F4	F4.4	(F3.5-F5.5)	.46
OD1 to TPec	F0.5	F0.2	(B1-F1.5)	.48
OV to TPec	0	F1.8	(F1-F3.5)	.59
Other Values				
Gill rakers in first lower gill arch	11	11.2	(10-12)	.58
Position of anus to TV	F1	F1.0	(0-F2)	.46
Vertebrae	29 #45	30.2	(29-31)	.59

Table 6 Characters distinguishing three closely related species of *Craterocephalus*.
*Data from Ivantsoff, 1978.

	<i>*C. marjoriae</i>		<i>C. helenae</i>		<i>C. marianae</i>	
	mean	range	mean	range	mean	range
Pectoral fin in SL	5.5	(4.9-6.4)	4.8	(4.1-5.0)	4.8	(4.4-5.3)
Snout in eye	1.2	(0.9-1.6)	1.0	(0.8-1.2)	1.0	(0.8-1.2)
Premaxilla in eye	1.2	(1.0-1.5)	1.0	(0.9-1.2)	1.0	(0.8-1.2)
Dorsal process of premaxilla in eye	1.4	(1.1-1.7)	1.1	(0.9-1.3)	1.1	(0.9-1.3)
Midlateral scales	29.4	(28-30)	31.2	(30-32)	28.4	(27-30)
Scales below mid-lateral band	3.5		2.5		2.5	
Gill rakers in first lower gill arch	11.1	(10-12)	8.9	(8-10)	11.2	(10-12)
Vertebral count	31.6	(30-34)	32.9	(32-33)	30.2	(29-31)
Gill raker shape	tubercular		reduced		reduced	
Position of anus in relation to tips of ventral fins	usually behind		at or in front		at or in front	
Colour patterns	dark blotch below midlateral band and above vent in NSW populations		no live specimens available		4th, 5th row with spots along side of body, patch absent	
Dorsal head scale	ovoid		rectangular		rectangular	
Premaxilla length	not reaching vertical through anterior margin of orbit		almost reaching vertical		reaching vertical	

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